Division of Agricultural Sciences

UNIVERSITY OF CALIFORNIA

# RISK AND DIVERSIFICATION FOR CALIFORNIA CROPS

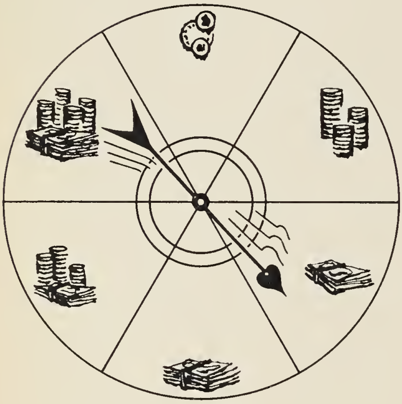
H. O. CARTER G. W. DEAN A. D. REED

CALIFORNIA AGRICULTURAL
Experiment Station
Extension Service

CIRCULAR 503

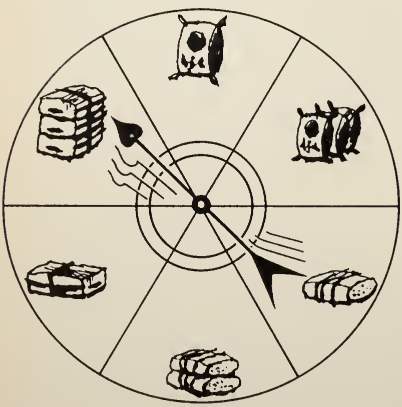
# RISK and

H. O. CARTER · G. W. DEAN · A. D. REED



*Certain unpredictable factors, such as weather, cause important variations in crop yields, prices, and income. In the past the farmer has had to rely primarily upon his own experience in estimating the risks associated with different crops and cropping systems. This circular supplements the grower's experience by presenting indexes of California crop variabilities in yields, prices, and income. Variabilities are expressed as relative percentages of variation from the average over a period of many years, and are based on a detailed study of California state and county agricultural records.*

*The information presented here will enable the California grower to better estimate the relative variations to be expected from year to year in yields, prices, and incomes of individual crops. Possibilities for reducing risks through crop diversification are also considered for several major farming areas of California.*



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**THE AUTHORS:**

H. O. Carter and G. W. Dean are Assistant Professors of Agricultural Economics, Assistant Agricultural Economists in the Experiment Station, and on the staff of the Giannini Foundation, Davis. A. D. Reed is Extension Economist and Associate on the Giannini Foundation, Davis.

**SEPTEMBER, 1961**

# DIVERSIFICATION for CALIFORNIA CROPS

Favorable soil and climatic conditions in California enable the majority of its farmers to select from among many different types of crops and cropping systems. Other considerations, such as access to markets, specialized abilities and experiences, availability of labor and mechanical equipment, and relative product and resource prices which may give comparative advantages, also influence decisions. Another important factor in selecting cropping systems is the farmer's attitude toward the uncertainty or risk associated with different crops. Individual views concerning the uncertainties of crop production are strongly influenced by past experience, but experience itself is often limited, or based on a "biased" sample of unusual years. The purpose of this publication, therefore, is to provide a more objective measurement of the uncertainty, or variability, associated with various crops and cropping systems in California.

The study on which this publication is based assumed that certain measures of the variability of crop prices, yields, and incomes could be established. These measures were based on 20 to 40 years of historical data. Assuming that future variability of particular crops is closely related to past variability, these measures should provide a more reasonable basis for making choices among crops. For example, it may be necessary for the grower to decide whether to produce: (a) high income crops having a correspondingly high risk of large losses, (b) lower risk crops having lower average income, or (c) a combination of high and low risk crops. New farmers who have limited capital, or who prefer not to gamble on high risk crops, can choose crop combinations which minimize risk and thus avoid the short-run possibility of bankruptcy. Established farmers, or those who have high risk preference, may wish to concentrate on high risk crops because they believe that high possible incomes may offset greater probabilities of large losses.

This circular also compares various crop diversification systems from the standpoint of variability and level of income between and within farming areas of California.

## MEASUREMENT OF VARIABILITY

Variability in crop production stems from factors which influence yields, prices, and incomes either in a predictable manner such as technical advances, or in an unpredictable manner such as weather. Farmers generally recognize long-run physical and economic trends such as technological advances, inflation, and price cycles and their effect on variability; in planning crop production for the year ahead, however, they are probably more interested in the unpredictable variability from current levels of prices or yields. Therefore, our variability estimates are measures of only this unpredictable portion of total variability.

Variability measures of individual crops have been derived from California state yield, price, and income data. For certain crops, yield variability may differ

from area to area because of differences in climate, resources, and economic conditions. In these cases, the variability measures derived from State data may not accurately represent regional variability. While this is a serious limitation for certain field crops grown throughout the State it is less serious for fruit and vegetable crops concentrated in localized areas. An additional problem is the fact that yield fluctuations on individual farms may be partially "evened-out" in compiling the State yield series.

Use of California state price data does not significantly misrepresent prices received, except in the case of certain fresh fruit and vegetable crops whose prices vary widely during a single shipping season. However, in this case the seasonal average price may be applicable since many farmers ship perishable crops at regular intervals throughout the harvesting season.

### Variability Index

The variability index developed by the authors of this circular shows, in percentage terms, the degree of random or unpredictable variability in crop prices, yields, or income, relative to the current level of these items. For example, the random variation (variation other than long-term trends) in sugar beet yields over the years has been about 1.2 tons per acre, while the current level of yields averages about 20 tons per acre. Accordingly, the yield variability index for sugar beets is $1.20 \div 20 = .06$, or 6 per cent. Variability indexes for price and income are computed similarly.

# VARIABILITY OF SELECTED CALIFORNIA CROPS

### Yield Variability

The following indexes measure only the yield fluctuations not associated with long-run trends resulting from technological developments and other production factors.

#### Field Crops

Table 1 presents variability indexes for nine major field crops grown in California. In general, the yield variability of field crops is quite low compared to other crops. The rankings here given correspond closely with common knowledge concerning relative yield variability of field crops. For example, alfalfa is ordinarily considered a very stable irrigated crop. At the other extreme, rice yield variability is affected by seasonal weather conditions, particularly temperatures during pollinization. Insects such as leaf miner, and parasites such as fresh water shrimp, can also influence rice yields markedly.

**TABLE 1. Selected Field Crops: Ranking by Yield Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Alfalfa | 3 |
| Barley | 5 |
| Potatoes (late) | 6 |
| Sugar beets | 6 |
| Potatoes (early) | 6 |
| Cottonseed | 7 |
| Wheat | 7 |
| Cotton lint | 9 |
| Rice | 10 |

#### Vegetables

Yield variabilities for 30 California vegetables are summarized in table 2. The most variable crops usually are those planted from November to February and harvested in the spring. Variable winter weather conditions contribute to the high relative yield uncertainty of these crops.

In general, vegetable crops show somewhat greater yield variability than field crops. This difference is due to the specialized skills, soils, and climatic conditions required for successful vegetable production.

**TABLE 2. Selected Vegetables: Ranking by Yield Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Tomatoes, early fall | 2 |
| Beans, green lima | 4 |
| Celery, winter | 5 |
| Tomatoes, processing | 5 |
| Onions, late summer | 6 |
| Celery, late fall | 6 |
| Celery, spring | 6 |
| Garlic, summer | 6 |
| Cauliflower, early spring | 7 |
| Peppers—Bell, late summer | 7 |
| Onions, late spring | 7 |
| Lettuce, early fall | 8 |
| Strawberries, mid-spring | 9 |
| Honeydews, late summer | 9 |
| Carrots, early summer | 9 |
| Lettuce, summer | 9 |
| Asparagus | 9 |
| Carrots, winter | 9 |
| Cauliflower, late fall | 10 |
| Snap beans, early fall | 10 |
| Tomatoes, early summer | 11 |
| Tomatoes, early spring | 11 |
| Cabbage, early spring | 11 |
| Cantaloupes, mid-summer | 12 |
| Lettuce, winter | 12 |
| Broccoli, early spring | 12 |
| Carrots, late fall | 13 |
| Lettuce, early spring | 15 |
| Cantaloupes, spring | 16 |
| Watermelons, late spring | 16 |

These variability estimates are based on yields per harvested acre. Because of economic conditions some planted acreage of certain crops may not be harvested, or a small portion only of the total yield per acre may be harvested. In short, prices at harvest affect the harvested yields per acre.

## Fruits and Nuts

Relative yield variabilities for 19 major California fruit and nut crops are presented in table 3. Yield variability coefficients average considerably higher for fruits and nuts than for vegetables and field crops, with olives, avocados, and apricots highest in yield variability. While most fruit and nut crops display an alternate bearing tendency (i.e., large crops followed by small crops and vice versa), the tendency is particularly strong in olive, avocado, and apricot crops. On the other hand, grapefruit, the least variable crop, shows very little alternate bearing tendency. Moreover, most California grapefruit is grown in desert areas where environmental factors are quite uniform. Although freestone peaches, which are second lowest in yield variability, exhibit an alternate bearing tendency the magnitude of year to year changes is small relative to recent yield levels.

**TABLE 3. Selected Fruits and Nuts: Ranking by Yield Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Grapefruit | 5 |
| Peaches, freestone | 7 |
| Figs | 9 |
| Grapes | 10 |
| Peaches, clingstone | 10 |
| Pears, all | 11 |
| Lemons | 11 |
| Oranges, navel | 13 |
| Plums | 13 |
| Prunes | 14 |
| Oranges, valencia | 17 |
| Almonds | 19 |
| Dates | 19 |
| Apples | 21 |
| Walnuts | 21 |
| Cherries | 24 |
| Apricots | 27 |
| Avocados | 29 |
| Olives | 31 |

## Price Variability

Price variability exerts an important influence on planting decisions. In this study, year to year fluctuation in prices is treated as the relevant variability for such decisions.

### Field Crops

Table 4 presents the price variability indexes for nine major California field crops. Crops with the lowest price variability indexes (wheat, sugar beets, rice, and barley) are those which have been subjected to a considerable degree of direct governmental control over a long period. Government price controls for cotton which have been of relatively short duration will, if continued, determine future price variability. At the other extreme, the price of early potatoes is very uncertain for the grower even though California is the major supplier of potatoes in the United States for a six-week period (from about May 15 to June 30). Because of the tendency for producers to over-respond to the previous year's potato prices, there has been great price variability for the crop.

**TABLE 4. Selected Field Crops: Ranking by Price Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Wheat | 4 |
| Sugar beets | 6 |
| Rice | 10 |
| Barley | 10 |
| Alfalfa | 11 |
| Cotton lint | 11 |
| Potatoes (late) | 19 |
| Cottonseed | 27 |
| Potatoes (early) | 43 |

### Vegetables

Although California is the nation's major vegetable producing state, many California vegetables are produced for specific and often limited markets. California producers take advantage of virtually year-around growing conditions to supply certain vegetables when the supply from competing areas is limited. As a result, California vegetable prices depend to an important extent upon supply conditions elsewhere. Although a number of vegetables in the upper range of price variability are in this specialized market category, the two major processing vegetables (tomatoes and asparagus) rank very low in price variability. Canneries and freezers which are located near growing districts provide a stable outlet for processed vegetables, and the prices of many such products are determined

**TABLE 5. Selected Vegetables: Ranking of Price Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Asparagus (all) | 5 |
| Snap beans, early fall | 6 |
| Tomatoes, processing | 7 |
| Peppers-Bell, late summer | 9 |
| Beans, green lima | 9 |
| Tomatoes, early summer | 12 |
| Tomatoes, early spring | 13 |
| Strawberries, mid-spring | 13 |
| Carrots, early summer | 13 |
| Tomatoes, early fall | 13 |
| Cantaloupes, mid-summer | 14 |
| Watermelons, late spring | 14 |
| Cauliflower, late fall | 15 |
| Cauliflower, early spring | 15 |
| Broccoli, early spring | 16 |
| Cantaloupes, spring | 17 |
| Honeydews, late summer | 17 |
| Lettuce, summer | 18 |
| Lettuce, winter | 19 |
| Carrots, late fall | 21 |
| Celery, late fall | 22 |
| Celery, winter | 22 |
| Carrots, winter | 24 |
| Lettuce, early fall | 25 |
| Lettuce, early spring | 26 |
| Garlic, summer | 31 |
| Onions, late spring | 31 |
| Celery, spring | 32 |
| Onions, late summer | 37 |
| Cabbage, early spring | 42 |

before the growing season starts. Table 5 gives relative price variabilities for 30 selected California vegetables.

### Fruits and Nuts

Table 6 ranks 19 California fruit and nut crops according to relative price variability. Grape prices have fluctuated violently in the past 20 years, making grapes the fruit crop with highest price variability. Raisin and wine outlets for grapes are highly interrelated; an oversupply or decline in demand for either affects prices for all grapes. Lemons, the second most price-variable fruit, also have shown wide price fluctuations in the past. A California state marketing order for lemon products, initiated in 1950 and since eliminated, did not significantly lessen price variability. However, the possibility that price-stabilizing marketing orders and agreements might be initiated for particular crops should be considered in estimating future price variabilities. The high price variability of olives can be traced largely to wide fluctuations in production (olives ranked highest in yield variability among the fruits, table 3).

Fruit and nut crops in the low price-variability range have one or more stabilizing influences. Two examples might be cited: grapefruit prices are stabilized because grapefruit production changes little from year to year (grapefruit ranked lowest in both yield and price variability); walnuts, although high in yield variability (table 3), tend to be stabilized in price by a Federal marketing order and by a strong grower-owned cooperative which handles a sizable proportion of the total crop.

**TABLE 6. Selected Fruits and Nuts: Ranking of Price Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Grapefruit | 11 |
| Apricots | 12 |
| Walnuts | 13 |
| Peaches, freestone | 14 |
| Prunes | 14 |
| Oranges, navel | 14 |
| Peaches, clingstone | 15 |
| Cherries | 17 |
| Apples | 17 |
| Figs | 20 |
| Plums | 20 |
| Oranges, valencia | 20 |
| Almonds | 21 |
| Dates | 21 |
| Avocados | 21 |
| Pears, all | 24 |
| Olives | 27 |
| Lemons | 27 |
| Grapes | 31 |

## Gross Income Variability

Ultimately, growers are interested in the net income variability of alternative crops and cropping systems. But net income variability results from the interaction of yield, price, and cost, and the impossibility of obtaining accurate cost data for all individual crops in California over a 40-year period necessitates the use of gross income (price × quantity) data in computing crop income variabilities. Net income variability is closely related to gross income variability, however, because costs tend to be stable or to change only gradually.

Gross income per acre is computed simply as the product of yield per acre and price. Thus, the year to year relationship between price and yields is important. If high prices tend to be associated with low yields and vice versa, this reduces gross income variability. This relationship is observed for many fruits where, with acreage relatively constant from year to year, changes in total production and prices depend primarily on changes in yields per acre.

### Field Crops

Table 7 presents gross income variability indexes for eight California field crops. Little year to year correlation be-

tween price and yield is evident for California field crops. Yield variability for field crops also is relatively low (table 1) and the most important factor contributing to gross income variability is price variability. The rankings of field crops by price and gross income variability are very similar (compare tables 4 and 7). Early and late potatoes are by far the most variable field crops with respect to both price and gross income; field crops influenced by price stabilizing government programs (sugar beets, barley, wheat, and rice) tend to be lowest in gross income variability.

**TABLE 7. Selected Field Crops: Ranking of Gross Income Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Sugar beets | 7 |
| Barley | 8 |
| Wheat | 8 |
| Rice | 10 |
| Alfalfa | 15 |
| Cotton | 15 |
| Potatoes (late) | 20 |
| Potatoes (early) | 35 |

### Vegetables

Table 8 shows the relative gross income variabilities of 30 major California vegetable crops. The ranking of the crops is quite consistent with the yield and price variability results derived earlier (tables 2 and 5). Vegetables low in both price and yield variability are concentrated at the lower end of the gross income variability scale. The most important of these crops in terms of total value are processing tomatoes and asparagus. Crops high in price variability tend to fall in the upper gross income variability range. As with field crops, price variability apparently outweighs yield variability as the major determinant of gross income variability.

**TABLE 8. Selected Vegetables: Ranking of Gross Income Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Snap beans, early fall | 7 |
| Tomatoes, processing | 8 |
| Asparagus (all) | 9 |
| Peppers—Bell, late summer | 9 |
| Tomatoes, early fall | 10 |
| Beans, green lima | 10 |
| Celery, late fall | 12 |
| Strawberries, mid-spring | 13 |
| Tomatoes, early spring | 13 |
| Cauliflower, early spring | 13 |
| Watermelons, late spring | 15 |
| Tomatoes, early summer | 15 |
| Carrots, early summer | 16 |
| Celery, winter | 17 |
| Honeydews, late summer | 17 |
| Broccoli, early spring | 18 |
| Lettuce, early fall | 19 |
| Cantaloupes, mid-summer | 20 |
| Carrots, late fall | 20 |
| Cauliflower, late fall | 20 |
| Onions, late summer | 20 |
| Lettuce, winter | 24 |
| Cantaloupes, spring | 26 |
| Carrots, winter | 26 |
| Garlic, summer | 27 |
| Celery, spring | 30 |
| Lettuce, summer | 31 |
| Onions, late spring | 35 |
| Lettuce, early spring | 41 |
| Cabbage, early spring | 44 |

### Fruits and Nuts

Table 9 ranks 19 major California fruit and nut crops in order of relative gross income variability. The correlation between price and yield for fruits and nut crops is important in determining gross income variability. The reasoning is as follows: California is the largest producer of most types of fruits and nuts consumed in the United States and the bearing acreages of these crops change only gradually from year to year. Therefore, major year to year changes in total national production result primarily from changes in California yields. Since total

national production and price tend to move in opposite directions, yield and price in California tend to do likewise. Thus, crops which have high individual price and yield variabilities may be relatively stable in income: if yield is low, prices are high—and vice versa. Cherries, valencia oranges, and avocados provide excellent examples of such price-yield relationships; these crops display relatively high yield and price variabilities (tables 3 and 6), yet are relatively stable in terms of gross income (table 9).

On the other hand, dates are the most variable fruit crop in terms of gross income (table 9), yet the individual yield and price variabilities for dates (tables 3 and 6) are only moderately high. The reason lies in a positive year to year yield-price relationship since 1940. Date imports were cut off during World War II, and California producers increased yields in response to record prices. Although inclusion of these "abnormal" years in the sample of annual observations possibly tends to provide an overestimate of gross income variability, the same positive year to year correlation between yields and prices has continued in general since World War II. In most instances, the individual yield and price variabilities of California fruit and nut crops are rather poor indicators of income variabilities because they ignore significant yield-price correlations.

**TABLE 9. Selected Fruits and Nuts: Ranking of Gross Income Variability Indexes**

| Product | Variability index per cent |
|---|---|
| Grapefruit | 5 |
| Oranges, navel | 7 |
| Cherries | 9 |
| Lemons | 10 |
| Oranges, valencia | 10 |
| Prunes | 11 |
| Peaches, freestone | 12 |
| Avocados | 12 |
| Plums | 15 |
| Walnuts | 15 |
| Almonds | 17 |
| Apples | 19 |
| Peaches, clingstone | 19 |
| Pears, all | 20 |
| Figs | 22 |
| Apricots | 22 |
| Grapes | 29 |
| Olives | 36 |
| Dates | 50 |

# CROP DIVERSIFICATION AS A MEANS OF LESSENING INCOME VARIABILITY

The main idea of crop diversification is to reduce risk by not "putting all your eggs in one basket." An ideal combination of crops is one wherein the low income from one crop is offset by a high income from a second crop, and vice versa. Unfortunately, while income can often be stabilized through diversification, the level of income may be lower than that obtained by specialization. Thus, the farmer may have to make a choice between an unstable income at a high average level and a more stable income at a lower level.

A cropping system cannot always be selected entirely on the basis of income stability. Certain crops may be included in cropping systems partly for soil building properties, and some crops may help control disease or weed problems; alfalfa or barley, for example, may be used to avoid nematode build-up in vegetables. The following analysis provides estimates of the income variability from a number of common crops and cropping systems in six agricultural areas of California: Sacramento Valley Rice Area, Yolo County, Fresno-Madera, Kings-Tulare

Lake Basin, Kern County, and Imperial Valley.

Since the number of crops and cropping systems considered in this section is relatively small, production costs were budgeted to allow use of net income data. Net income per acre is defined as gross income (yield per acre × annual average price) minus operating costs. Depreciation, taxes, and other fixed charges would have to be deducted in each case to arrive at net profits. Individual county yields or weighted average county yields (where more than one county is located in an area), were used for most crops. Prices were based on California state data. Operating costs for each crop in each area were obtained by simple budget and cost studies. Where harvesting costs constitute a major cost item, the costs were adjusted for the yield level.

For purposes of comparison the variability indexes presented in table 10 below are based on cropping systems for 560-acre farms, with the 560 acres divided equally among the respective crops.

### Sacramento Valley Rice Areas

As land in the rice area is shifted from rice alone (560 acres of rice) to a cropping pattern of R-R-R-B (420 acres of rice and 140 acres of barley) the net income (gross income minus operating costs only) decreased from $48,000 to $39,000. However, the variability index remained essentially unchanged. Similarly, the diversion of 140 acres of rice to wheat (R-R-R-W rotation) results in a reduction in the expected average net income to $40,000 but with only a small reduction in the variability from 28 to 26 per cent. Diverting the 140 acres to summer fallow (R-R-R-F) rather than wheat or barley results in a considerable reduction in average income compared to rice alone and a slight increase in the relative variability coefficient from 28 to 29 per cent. Rotation of rice land to dry farmed grain or summer fallow is generally considered a necessary control for weeds. From the results shown, rice rotations with either barley or wheat allow a lower income variability than with summer fallow, but with less reduction in net income.

### Yolo County

Variability estimates for four different crop combinations are derived for the Yolo County area. Alfalfa (3 years) was considered a mainstay in all rotations. Some of the cash crops commonly grown with alfalfa are sugar beets, tomatoes, and barley. In Yolo County, tomatoes (owner-operator) has the greatest absolute or dollar net income variability while dryland barley has the lowest absolute net income variability. (Absolute or dollar variability is simply the variability index expressed decimally times the average net income.) Relative income variability for individual crops (as indicated by the variability indexes) is greatest for alfalfa and sugar beets (33 and 25 per cent, respectively). Combinations of these individual crops resulted, in most cases, in a reduction in both absolute and relative income variability. For example, the cropping system A-A-A-SB-T-SB shows a variability index of only 15 per cent.

The A-A-A-T-SB-B and A-A-A-T(L)-SB-B rotations have approximately equal net income variability indexes, but the latter rotation reduces average net income from $37,000 to $30,000. In the A-A-A-SB-B-B combination, a relatively large proportion of the land is devoted to low income barley and the reduction in dollar income variability is achieved at a sizable sacrifice of net income. Consequently, the relative variability for A-A-A-SB-B-B is the highest of those combinations considered in Yolo County.

### Fresno-Madera Area

Table 10 summarizes the variability estimates for alfalfa and three cash crops both individually and in various crop combinations. The income index for al-

## TABLE 10. Net Income Variability Comparisons Between Selected Crops and Crop Combinations in Six Areas of California (Assuming a 560-acre farm)

| Crop combination* | Average net income 1953–1957† dollars | Variability index‡ per cent |
|---|---|---|
| **Sacramento Valley Rice Areas** | | |
| Rice | 48,000 | 28 |
| Wheat | 14,000 | 20 |
| Barley | 12,000 | 22 |
| R-R-R-B | 39,000 | 27 |
| R-R-R-W | 40,000 | 26 |
| R-R-R-F | 35,000 | 29 |
| **Yolo County** | | |
| Alfalfa | 28,000 | 33 |
| Sugar beets | 39,000 | 25 |
| Tomatoes (owner-operator) | 82,000 | 20 |
| Tomatoes (leased) | 36,000 | 9 |
| Barley (dryland) | 14,000 | 24 |
| A-A-A-SB-T-SB | 41,000 | 15 |
| A-A-A-T-SB-B | 37,000 | 18 |
| A-A-A-T(L)-SB-B | 30,000 | 17 |
| A-A-A-SB-B-B | 25,000 | 25 |
| **Fresno-Madera Area** | | |
| Alfalfa | 22,000 | 42 |
| Cotton | 89,000 | 36 |
| Sugar beets | 28,000 | 55 |
| Cantaloupes | 74,000 | 76 |
| A-A-A-Ca | 35,000 | 45 |
| A-A-A-C-SB | 37,000 | 21 |
| A-A-A-C-C-SB | 45,000 | 23 |
| A-A-A-C-C-Ca | 53,000 | 28 |
| A-A-A-C-SB-Ca | 44,000 | 28 |
| A-A-A-SB | 24,000 | 35 |
| A-A-A-SB-Ca | 34,000 | 39 |
| **Kings-Tulare Lake Basin** | | |
| Alfalfa | 29,000 | 35 |
| Cotton | 86,000 | 29 |
| Barley | 9,000 | 42 |
| A-A-A-C-B | 36,000 | 19 |
| **Kern County** | | |
| Alfalfa | 31,000 | 36 |
| Cotton | 105,000 | 28 |
| Sugar beets | 27,000 | 70 |
| Potatoes | 90,000 | 136 |
| Barley | 9,000 | 42 |
| A-A-A-P-P | 54,000 | 93 |
| A-A-A-C-C-C | 68,000 | 21 |
| A-A-A-SB-C-SB | 42,000 | 27 |
| A-A-A-C-C-P | 65,000 | 35 |
| A-A-A-C-B-P | 50,000 | 44 |
| A-A-A-C-P | 58,000 | 45 |
| A-A-A-SB-B-P | 37,000 | 64 |
| **Imperial Valley** | | |
| Alfalfa | 35,000 | 33 |
| Cotton | 94,000 | 22 |
| Sugar beets | 54,000 | 18 |
| Barley | 15,000 | 17 |
| A-A-A-C-C-SB | 49,000 | 20 |
| A-A-A-C-B-SB | 36,000 | 22 |
| A-A-A-C-C-C | 56,000 | 23 |
| A-A-A-C-C-B | 42,000 | 23 |

* Assumes equal proportions of the 560-acre farm devoted to each crop in the crop combination. For example, "Rice" refers to 560 acres of rice alone; R-R-R-B refers to 420 acres of rice and 140 acres of barley. Symbols are defined as: A – alfalfa, B – barley, C – cotton, Ca – cantaloupes, SB – sugar beets, R – rice, W – wheat, F – fallow, T – tomatoes (owner handles complete operation), T(L) – tomatoes (owner leases land in return for 17 per cent of gross income), and P – potatoes.

† Net income refers to gross income minus operating costs (excluding depreciation, taxes, and interest on investment).

‡ The variability index measures relative variability. Absolute or dollar variability can be obtained by multiplying average net income by the variability index expressed decimally. For example, the absolute variability of wheat in the Sacramento Valley Rice Area is $2,800 ($14,000 x .20).

falfa in the Fresno-Madera area is comparably high mainly because of low relative yield as reflected in the average net income. Cantaloupes are a high risk crop as well as a high value crop; the inclusion of cantaloupes into most cropping systems tends to increase both income levels and income variability. For example, the diversion of 140 acres of the total 560 acres from alfalfa to cantaloupes (the A-A-A-Ca combination) increases the expected net income from $22,000 to $35,000 but results in an increase in the variability index from 42 to 45 per cent. Similarly, a comparison of A-A-A-C-C-SB with A-A-A-C-C-Ca indicates that cantaloupes rather than sugar beets increase both the level and variability of net income. Comparison of A-A-A-C-SB-Ca and A-A-A-C-C-Ca indicates that substitution of cotton for sugar beets increases the income level but leaves the variability index unchanged.

### Kings-Tulare Lake Basin

Barley has the lowest absolute or dollar income variablity for the single crops studied in the Kings-Tulare Lake Basin area. Barley, however, was also the lowest income crop ($9,000) and showed the greatest relative variability. Conversely, cotton exhibited the greatest absolute income variation but the lowest relative variability. The only cropping pattern analyzed in this area was three years of alfalfa followed by cotton and barley. Diversion of 280 acres of alfalfa to 140 acres each of cotton and barley reduces both the absolute and relative income variability from that shown for alfalfa grown alone, yet the level of income is increased from $29,000 to $36,000.

### Kern County

Crop production in Kern County generally shows greater income variability than in the other five areas. A large part of the sugar beet income variability is related directly to an unstable yield record. Also, average net income from sugar beets is substantially lower in Kern County than in most other areas, resulting in a high variability index (70 per cent). As previous estimates indicate. early potatoes are the most risky crop, with a variability index of 136 per cent. The high net income variability of early potatoes in Kern County is dramatized further by the fact that net income per acre in recent years has varied from –$105 to $677. Therefore. the addition of potatoes to any rotation system increases both the absolute and relative income variability. For example, the Kern County cropping system with the greatest variability is A-A-A-P-P; the variability index is 93 per cent. In general, the addition of cotton to the rotation tends to decrease the variability index.

### Imperial Valley

Table 10 indicates that individual Imperial Valley alfalfa, cotton, sugar beets, and barley crops are relatively stable. As with most of the other areas, cotton has the greatest dollar income variability but, since it is a high value crop, relative variability is low. Of the cropping patterns selected (assuming equal acreages in each crop) no substantial differences in relative net income variability were observed. Also, the magnitudes of the variability coefficients were low, ranging from 20 to 23 per cent. The addition of some high risk vegetable crops, such as lettuce, into these cropping systems would substantially alter this situation.

Co-operative Extension work in Agriculture and Home Economics, College of Agriculture, University of California, and United States Department of Agriculture co-operating. Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914. George B. Alcorn, Director, California Agricultural Extension Service.

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